

Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/US05/006179

International filing date: 26 February 2005 (26.02.2005)

Document type: Certified copy of priority document

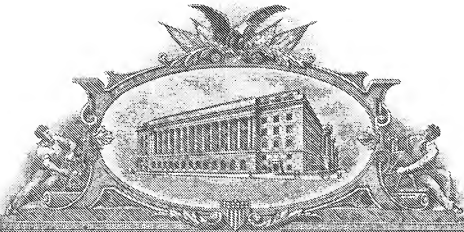
Document details: Country/Office: US
Number: 10/790,571
Filing date: 01 March 2004 (01.03.2004)

Date of receipt at the International Bureau: 23 March 2005 (23.03.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)



World Intellectual Property Organization (WIPO) - Geneva, Switzerland
Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse



THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

March 15, 2005

THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.

APPLICATION NUMBER: *10/790,571*

FILING DATE: *March 01, 2004*

RELATED PCT APPLICATION NUMBER: *PCT/US05/06179*



Certified by

Under Secretary of Commerce
for Intellectual Property
and Director of the United States
Patent and Trademark Office

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No. FLUX 2004-1

First Inventor Phillip Corbin III

Title **AN APPARATUS FOR TRANSFERRING TORQUE MAGNETICALLY**

Express Mail Label No. ER 963919602 US

 22856 9170
 1596107
 10709571
 030104

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO:

 Mail Stop Patent Application
 Commissioner for Patents
 P.O. Box 1450
 Alexandria VA 22313-1450

1. ☒ Fee Transmittal Form (e.g., PTO/SB/17)
(Submit an original and a duplicate for fee processing)
2. ☒ Applicant claims small entity status.
See 37 CFR 1.27.
3. ☒ Specification [Total Pages 20]
(Preferred arrangement set forth below)
- Descriptive title of the invention
- Cross Reference to Related Applications
- Statement Regarding Fed sponsored R & D
- Reference to sequence listing, a table, or a computer program listing appendix
- Background of the Invention
- Brief Summary of the Invention
- Brief Description of the Drawings (if filed)
- Detailed Description
- Claim(s)
- Abstract of the Disclosure
4. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets 7]
5. Oath or Declaration [Total Sheets 3]
a. ☒ Newly executed (original or copy)
b. ☐ Copy from a prior application (37 CFR 1.63(d))
(for continuation/divisional with Box 18 completed)
i. ☐ **DELETION OF INVENTOR(S)**
Signed statement attached deleting inventor(s) name in the prior application, see 37 CFR 1.53(d)(2) and 1.33(b).
6. ☐ Application Data Sheet. See 37 CFR 1.76

7. ☐ CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix)
8. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
a. ☐ Computer Readable Form (CRF)
b. Specification Sequence Listing on:
i. ☐ CD-ROM or CD-R (2 copies); or
ii. ☐ Paper
c. ☐ Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9. ☐ Assignment Papers (cover sheet & document(s))
10. ☐ 37 CFR 3.73(b) Statement (when there is an assignee) ☐ Power of Attorney
11. ☐ English Translation Document (if applicable)
12. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations
13. ☐ Preliminary Amendment
14. ☐ Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
15. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)
16. ☐ Nonpublication Request under 35 U.S.C. 122 (b)(2)(B)(i). Applicant must attach form PTO/SB/35 or its equivalent.
17. ☐ Other:

18. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in the first sentence of the specification following the title, or in an Application Data Sheet under 37 CFR 1.76:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No.:

Prior application information: Examiner

Art Unit:

For CONTINUATION OR DIVISIONAL APPS only; The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

19. CORRESPONDENCE ADDRESS

☐ Customer Number: OR ☒ Correspondence address below

Name	The Miller Law Offices, PLC				
Address	801 Brickell Avenue				
	Suite # 900				
City	Miami	State	FL	Zip Code	33131
Country	USA	Telephone	305-803-5168	Fax	800-881-6174
Name (Print/Type)	Steven J. Miller, Esq.		Registration No. (Attorney/Agent)		48368
Signature	<i>Steven J. Miller</i>		Date	March 1, 2004	

This collection of information is required by 37 CFR 1.53(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop Patent Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

**FEE TRANSMITTAL
for FY 2004**

Effective 10/01/2003. Patent fees are subject to annual revision.

☒ Applicant claims small entity status. See 37 CFR 1.27**TOTAL AMOUNT OF PAYMENT** (\$) **638.00****Complete if Known**

Application Number	
Filing Date	
First Named Inventor	Philip Corbin III
Examiner Name	
Art Unit	
Attorney Docket No.	FLUX 2004-1

METHOD OF PAYMENT (check all that apply)☒ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None☐ Deposit Account:

Deposit Account Number	
Deposit Account Name	

The Director is authorized to: (check all that apply)

☐ Charge fee(s) indicated below ☐ Credit any overpayments
☐ Charge any additional fee(s) or any underpayment of fee(s)
☐ Charge fee(s) indicated below, except for the filing fee to the above-identified deposit account.
FEE CALCULATION**1. BASIC FILING FEE**

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid
1001 770	2001 385	Utility filing fee	385
1002 340	2002 170	Design filing fee	
1003 530	2003 265	Plant filing fee	
1004 770	2004 385	Reissue filing fee	
1005 160	2005 80	Provisional filing fee	

SUBTOTAL (1) (\$) **385.00****2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE**

Total Claims	Extra Claims	Fee from below	Fee Paid
32	-20** = 12	x 9	108
2	-3** =	x	0
			145

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description
1202 18	2202 9	Claims in excess of 20
1201 86	2201 43	Independent claims in excess of 3
1203 290	2203 145	Multiple dependent claim, if not paid
1204 86	2204 43	** Reissue independent claims over original patent
1205 18	2205 9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) (\$) **253.00**

**or number previously paid, if greater. For Reissues, see above

FEE CALCULATION (continued)**3. ADDITIONAL FEES**

Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid
1051 130	2051 65	Surcharge - late filing fee or oath	
1052 50	2052 25	Surcharge - late provisional filing fee or cover sheet	
1053 130	1053 130	Non-English specification	
1812 2,520	1812 2,520	For filing a request for <i>ex parte</i> reexamination	
1804 920*	1804 920*	Requesting publication of SIR prior to Examiner action	
1805 1,840*	1805 1,840*	Requesting publication of SIR after Examiner action	
1251 110	2251 55	Extension for reply within first month	
1252 420	2252 210	Extension for reply within second month	
1253 950	2253 475	Extension for reply within third month	
1254 1,480	2254 740	Extension for reply within fourth month	
1255 2,010	2255 1,005	Extension for reply within fifth month	
1401 330	2401 165	Notice of Appeal	
1402 330	2402 165	Filing a brief in support of an appeal	
1403 290	2403 145	Request for oral hearing	
1451 1,510	1451 1,510	Petition to institute a public use proceeding	
1452 110	2452 55	Petition to revive - unavoidable	
1453 1,330	2453 665	Petition to revive - unintentional	
1501 1,330	2501 665	Utility issue fee (or reissue)	
1502 480	2502 240	Design issue fee	
1503 640	2503 320	Plant issue fee	
1460 130	1460 130	Petitions to the Commissioner	
1807 50	1807 50	Processing fee under 37 CFR 1.17(q)	
1806 180	1806 180	Submission of Information Disclosure Stmt	
8021 40	8021 40	Recording each patent assignment per property (times number of properties)	
1809 770	2809 385	Filing a submission after final rejection (37 CFR 1.129(a))	
1810 770	2810 385	For each additional invention to be examined (37 CFR 1.129(b))	
1801 770	2801 385	Request for Continued Examination (RCE)	
1802 900	1802 900	Request for expedited examination of a design application	

Other fee (specify)

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (\$) **0.00****SUBMITTED BY**

Name (Print/Type)	Steven J. Miller, Esq	Registration No. (Attorney/Agent)	48368	Telephone	3058035168
Signature	<i>Steven J. Miller</i>	Date	March 1, 2004		

(Complete if applicable)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

This collection of information is required by 37 CFR 1.17 and 1.27. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Certificate of Mailing under 37 CFR 1.8

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to:

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450 via US Express Mail #ER 963919602US

on March 1, 2004
Date


Signature

Steven J. Miller, Esq.

Typed or printed name of person signing Certificate

Note: Each paper must have its own certificate of mailing, or this certificate must identify each submitted paper. Documents included: Utility Patent Application Transmittal form, Fee Transmittal for 2004, Declaration for Utility Patent Application (3 pages), Utility Patent Specification (20 pages), Patent Application Drawings (7 pages), Check to Commissioner for Patents-Amount=\$638.00, Certificate of Mailing, Documents mailed Return Postcard.

This collection of information is required by 37 CFR 1.8. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1.8 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

An Apparatus for Transferring Torque Magnetically

U.S. Patent Application of:

Philip Corbin III; Robert L. Dahlin; John A. Molnar; John B. Rusconi; Walter F. Strong

"Express mail" mailing label number
ER 963919602 US

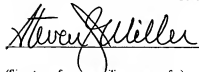
Date of Deposit: March 1, 2004

I hereby certify that this correspondence, including the attachments listed on the accompanying New Utility Patent Application Transmittal, is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is

addressed to
Mail Stop Patent Applications
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450.

STEVEN J. MILLER, ESO.

(Typed or printed name of person mailing paper or fee)

A handwritten signature in dark ink, appearing to read "Steven J. Miller", is written over a horizontal line.

(Signature of person mailing paper or fee)

TITLE OF THE INVENTION

An Apparatus for Transferring Torque Magnetically.

CROSS REFERENCE TO RELATED APPLICATIONS

Not Applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not Applicable.

Description of Attached Appendix

Not Applicable.

TECHNICAL FIELD OF THE INVENTION

The present invention relates to rotational magnetic torque transfer devices utilizing two coaxial cylinders overlapping one another wherein one cylinder contains a row(s) of permanent magnets and the other cylinder contains a ring(s) of electroconductive material.

BACKGROUND OF THE INVENTION

It is desirable to devise a permanent magnet excited mechanism for transmitting variable torque in drive applications. Specifically there is a need to couple constant speed devices such as motors or engines to variable output speed and torque devices such as pump impellers, fans, propellers, wheels, etc. Transmission devices including

various eddy current clutches have been in use for some time in various forms. An examination of the prior art shows that these eddy current devices are limited to three general types

1. Fixed gap clutches that use permanent magnets. These devices are limited to specific set gaps and output torque and are specific to low torque applications.
2. Eddy current clutches that use DC current to generate and vary the flux density in a fixed gap mechanism. These devices are available in a wide range of horse power but are expensive, complicated and require a DC current and control to induce the torque. There are applications where the DC current is not desirable or where the apparatus for controlling the torque producing currents are unreliable.
3. Current variable gap permanent magnet disk clutches are limited in their ability to transmit large amounts of torque and are constructed in a manner which causes instability at higher speeds. These limitations relegate the practical application of these devices to low speed, low horsepower application.

The apparatus described utilizes recent developments in magnetic material technology, in conjunction with architecture designed for mechanically stable operation. This will allow the apparatus to be used in a full range of power transmission applications including high horsepower applications. The configuration of the device also makes it

stable and able to operate at higher input speeds, which are natively present in some motors and engines.

The described apparatus is a device that uses permanent magnets and conductors arranged in an optimal manner to generate the magnetic flux in a power transmission drive. The embodiments described utilize a mechanical means for changing the flux density between two rotating components to vary the torque transmitted by and thereby the output speed of the apparatus.

BRIEF SUMMARY OF THE INVENTION

The present invention utilizes permanent magnets to transmit variable torque between two rotating elements. The torque between the elements is adjusted by mechanically varying the amount of magnetic flux passing between the elements by varying the extent to which the elements are axially overlapped. In a preferred embodiment of the apparatus, two concentric cylinders, one containing one or more rows of permanent magnets, is moved axially in order to progressively axially overlap a second cylindrical element containing electrically conductive and magnetically conductive elements. This progressive axial overlapping of the two cylinders allows variation in the amount of magnetic flux intersecting the two concentric cylinders. This causes the amount of induced electrical current in the cylinder containing the electro-conductive elements to vary, which then causes the induced counter magnetic forces to vary. The magnetic forces and, thus, torque transmitted will vary based on the amount of axial overlap.

The proposed invention overcomes previous limitations by taking advantage of new technologies in magnet materials and provides a stable means of mechanically varying large amounts of transmitted torque without the need for large external current controls.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings constitute a part of this specification and include exemplary embodiments to the invention, which may be embodied in various forms. It is to be understood that in some instances various aspects of the invention may be shown exaggerated or enlarged to facilitate an understanding of the invention.

Description of selected embodiments of the invention included herein are listed as follows:

Figure 1 is an isometric view of the exterior of a preferred embodiment of the invention.

Figure 2 is a sectioned isometric view of the preferred embodiment of the invention.

Figure 3 is section view through the preferred embodiment of the invention.

Figure 4 is an exploded section view showing the various major parts of the described preferred embodiment of the invention.

Figure 5 is a section view of an alternate form of electrically conductive cylinder as described in the alternate embodiment of the invention.

Figure 6 is an isometric of an alternate embodiment of the invention.

Figure 7 is a cut away through the isometric of the alternate embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Detailed descriptions of preferred embodiments are provided herein. It is to be understood, however, that the present invention may be embodied in various forms. Therefore, specific details disclosed herein are not to be interpreted as limiting, but rather as a basis for the claims and as a representative basis for teaching one skilled in the art to employ the present invention in virtually any appropriately detailed system, structure or manner.

Referring to figures 1 through 4, a first embodiment of the invention is shown and described as it applies to a variable speed drive application. The first part of the variable speed torque transfer apparatus described in this preferred embodiment consists of a primary rotary member comprising an input shaft rotor (2), a support cylinder (3), and a magnet-carrying rotor (4), all mechanically connected together, and constrained to rotate at the same angular velocity together. The second part of the variable speed torque transfer apparatus described in this preferred embodiment consists of a secondary rotary member comprising an output shaft rotor (1), magnetically permeable ferrous wheels (7) which support and back the electro-conductive rings (6), all mechanically connected together, and constrained to rotate at the same angular velocity together. The input shaft (2) is connected directly to a concentric support cylinder (3), which is constrained to rotate with the input shaft (2). The support cylinder (3) and input shaft (2) are supported by two input shaft support bearings (12) located at each end of the support cylinder (3). These two bearings (12) are in turn, supported by the apparatus exterior protective enclosure (30), which has mounting feet (31) on its underside section. These mounting feet are then attached to a

type of machinery a foundation (not shown). A separate magnet-carrying rotor (4) is mounted concentrically within the support cylinder (3) and is constrained to rotate with the support cylinder (3). The magnet-carrying rotor (4) is also constrained to move axially with respect to the support cylinder (3) while maintaining its rotational and concentric relationship with the support cylinder (3). In the preferred embodiment the constraints are comprised of four pairs of rollers (14) whose axles are radially positioned on the magnetic carrying cylinder and disposed to engage and run in longitudinal slots (15) in the support cylinder (3). It is noted that those skilled in the art could conceive of other means for supporting and constraining the magnet-carrying rotor (4). In this preferred embodiment, the interior surface of the magnet-carrying rotor (4) contains one or more annular arrays, each array consisting of a plurality of magnets (5) which are arrayed radially around the internal periphery of the magnet-carrying rotor (4). The poles of the magnets (5) are geometrically positioned to be radial and are magnetically arranged so that the polarity varies at each successive magnet, i.e. north then south, or alternately, in groups, so that the polarity alternates only after a plurality of magnets of a particular polarity (north or south) are grouped together. The magnetic poles face radially inward around the periphery of the cylinder. In the preferred embodiment described, three such arrays of alternating magnets are included. The invention is not limited by the length of the magnets, quantity of magnets in each annular ring and the number of annular magnetic rings. The support cylinder (3) immediately surrounding and supporting the magnets is made from a magnetically permeable material, preferably iron or steel. The purpose of using magnetically permeable material is to provide a continuous magnetic flux path between the magnetic pole faces, thereby allowing

optimum magnetic flux arrangements to exist. Located concentrically inside of the magnet-carrying rotor (4) and not constrained to rotate with the magnet-carrying rotor (4), are electro-conductive rings (6) mounted circumferentially on magnetically permeable ferrous wheels (7), connected to, and constrained to rotate with, an output shaft (1). The electro-conductive rings (6) are separated from the faces of the magnets (5) by a small radial gap, which allows clearance for the primary and secondary rotary members to rotate independently of each other. Each such cylinder consists of an external ring of material with a good electrical conductivity (6), manufactured from a conductive material such as copper or aluminum, and interior support wheels (7) manufactured from a magnetically permeable material such as iron or steel. It is preferable that the magnetically permeable material be constructed from thin laminated pieces of ferrous material, in which the laminated pieces are coated with an electrically insulative material with a high dielectric value. These laminated pieces are stacked together to form the cylindrical support for the electro-conductive material rings (6). It is the purpose of the magnetic material to allow for a complete magnetic path through the electro-conductive layer and back the magnets. The laminations will reduce large scale undesirable eddy currents from being induced in the magnetically permeable material. The electro-conductive rings (6), their support wheels (7), and the output shaft (1) are supported by two output shaft support bearings (11) located at each end of the output shaft (1).

In operation, the poles of the magnets (5) mounted to the magnet-carrying rotor (4) pass over the electro-conductive material, as the magnet-carrying rotor (4) rotates. This action will induce electrical currents in the electro-conductive rings (6) and

the induced magnetic forces produced by the currents in these rings (6) will cause magnetic interaction between the rotors, and thereby cause torque to be transmitted between the magnet ring (5) and the rings (6), their support wheels (7), and attached output shaft (1). The torque will vary based on the relative rotational speed of primary rotary member and the secondary rotary member, and the amount of axial overlap between the magnet rings (5) and the electro-conductive rings (6). As one experienced in the art will realize, the number of annular arrays of magnets (5) with corresponding wheels of electro-conductive rings (6) used, can vary from one to a plurality, and the invention is not limited by the number of these rings selected or utilized.

The magnetic-carrying rotor (4) being movable axially within the support cylinder (3), allows for the amount of axial overlap of the rings of magnets (5) to the electro-conductive rings (6) to be adjustable by means of this variable axial motion. With magnet-carrying rotor (4) positioned so that the annular rings of magnets (5) are fully staggered or offset between the electro-conductive material rings (6), so that very small amount of axial overlap exists, a minor amount of magnetic flux is transmitted between the magnet-carrying rotor (4) and the electro-conductive rings (6), and therefore a very small amount of torque is transmitted between the primary rotary member and the secondary rotary member. As the magnetic-carrying rotor (4) moves axially within its support cylinder (3), the amount of axial overlap between the magnetic rings (5) and the electro-conductive rings (6) increases. As the amount of axial overlap increases, the amount of magnetic flux intersecting the electro-conductive rings (6) increases. This causes the amount of electrical current induced in the electro-conductive rings (6) to

increase, which thereby causes more torque to be transmitted, until at full overlap axial position, maximum transmitted torque is achieved.

In the preferred embodiment described, control of the axial position of the magnetic-carrying rotor (4) relative to the electro-conductive rings (6), is provided by motion transmitted from an exterior linkage (9) which positions a trunnion and ring (13) carrying the outer race of a thrust transmitting bearing (8). The inner race of the thrust bearing (8) is attached directly to the magnet-carrying rotor (4). The inner race of the thrust bearing (8) is supported at protruding attachment locations (29) which extend radially outward through slots (21) in support cylinder (3). The mechanism described will position the magnet-carrying rotor (4) by virtue of motion of the exterior linkage. An individual skilled in the art will realize that a number of alternate means internal and external are also available for the positioning of the magnet-carrying rotor (4). A means is provided for moving and positioning the magnet-carrying rotor (4) via the mechanism (9). In the described embodiment, the means shown is a hydraulic cylinder (10), but the invention is not restricted to this means solely. Other means may be used to move the magnet-carrying rotor (4) axially. Other means include, but are not limited to, manual actuation by a mechanical lever, electro-mechanical self-synchronous devices, or an actuator with a drive screw arrangement. Other applicable means of adjustment would be selected largely depending on the intended application of the apparatus.

In the embodiment as depicted in figures 2 and 4, open slots are included through the apparatus end caps (26), the wheels (7), and the end caps (28) of the support cylinder (3). These slots allow for the passage of cooling air through the apparatus. It is recognized that heat will be generated as a result of the electrical

currents generated in the rotors of the apparatus. As such, means may be provided for the removal of excessive heat. These means can include ventilation as shown in the embodiment of Figures 2 and 4, forced air convective heat transfer (not shown), sealed direct refrigerant cooling (not shown), or forced liquid cooling (not shown).

An alternative embodiment is depicted in figure 5, 6 and 7. The first part of the variable speed torque transfer apparatus described in this alternative embodiment consists of a primary rotary member comprising an input shaft rotor (118) and a magnet-carrying rotor (120), mechanically connected together, and constrained to rotate at the same angular velocity together. The second part of the variable speed torque transfer apparatus described in this alternative embodiment consists of a secondary rotary member comprising an output shaft rotor (117), magnetically permeable ferrous cylinder (122), which supports and backs an electro-conductive ring (116), all mechanically connected together, and constrained to rotate at the same angular velocity. In this embodiment, a magnet-carrying rotor (120) is attached directly to the input shaft (118). The array of magnets (119) rotate with the magnet-carrying rotor (120) and are constrained by the rotor to move concentrically about the center of rotation of the shaft (118) and to move synchronously with the shaft (118). As in the previous embodiment, the poles of the magnets (119) are geometrically positioned to be radial and are magnetically arranged so that the polarity varies at each successive magnet, i.e. north then south, or alternately, in groups, so that the polarity alternates only after a plurality of magnets of a particular polarity (north or south) are grouped together. The poles point radially inward toward the axis of rotation. An output shaft (117) is constrained to rotate coaxially with the input shaft (118) by bearings (125). A

rotor cylinder (122) is mounted on the output shaft (117) and is constrained to rotate synchronously with the output shaft (117) by means of a male spline machined into the output shaft (117). A mating female spline on the rotor cylinder (122) constrains the cylinder to rotate in unison with the output shaft (117) and allows the magnet-carrying rotor (120) to move axially along the output shaft (117). The axial overlap between the ring of magnets (119) and the electro-conductive cylinder (116) of the rotor can be varied by this means. The inner cylinder (122) supports and backs an electro-conductive cylinder (116). In the embodiment described, the electro-conductive cylinder (116) is in the alternate form of a circumferential ladder type of arrangement with conductive bars joined to conductive end rings. This type of geometry is useful in shaping the direction of the electrical current flow generated by the passing proximity of a magnetic field of the magnet-carrying rotor (120). The electro-conductive ring (116) may also have the geometric form of a smooth solid cylindrical ring. Either embodiment, the smooth cylindrical ring, or the circumferential ladder arrangement, or variations of either, can be used depending on the specified properties of the application. The invention is not limited by the choice of this geometric form. As with the first embodiment, the magnet-carrying rotor (120) is made up of magnetically permeable material to lower the reluctance of the magnetic circuit. The cylindrical rotor (122) supporting the electro-conductive cylinder (116), is fabricated with magnetically permeable material, which completes the magnetic field circuit extending from the rotating magnet ring (119) through the electro-conductive ring (116). As with the first embodiment, it is preferable to construct the magnetically permeable rotor cylinder (122) from thin pieces of electrically insulated ferrous material to reduce undesirable eddy

currents in the material. In this embodiment, the rotor cylinder's (122) magnetically permeable material extends up through the openings in the electro-conductive ring (116). This reduces the radial gap between the magnet ring (119) and the electro-conductive ring (116), and thereby increases the magnetic flux while allowing the induced current in the electro-conductive cylinder (116) to surround the magnetically permeable material. This geometry is ideal for producing strong induced electromagnetic fields in the rotors, thereby maximizing the transmitted torque.

A single row of magnets (119) and a single electro-conductive ring (116) are shown in this second embodiment. One skilled in the art would recognize that, additional rows of magnets (119) with corresponding electro-conductive cylinder rings (116), could be utilized. A yoke (123) is positioned in a groove (126) in the flange of the output rotor support cylinder. The yoke allows axial positioning of the rotor (122), thereby changing the amount of axial overlap with the magnetic ring (119) of the magnet-support rotor (120). The amount of magnetic flux transmitted and thus torque transferred, is dependent of the amount of axial overlap of the two rotors. A means is provided for positioning the yoke and rotor cylinder. In this embodiment, axial thrust to actuate and move the electro-conductive ring rotor (116) axially, is provided mechanically through the rod (124). The means to axially move this rod (124) are not shown in this alternate embodiment, but one skilled in the art would recognize the various options for axially moving the electro-conductive ring (116) rotor relative to the magnet-carrying rotor (120), as described in the first embodiment.

One skilled in the art will also recognize that other arrangements of the elements described in the embodiments above are also covered in another embodiment

(not shown), the function of the input shaft rotor and output shaft rotors can be functionally exchanged, and the operation of the invention will still work properly.

In another embodiment (not shown), the rings of magnets are mounted in the inner cylindrical rotor with the electro-conductive ring on the exterior cylinder. In these cases, the apparatus would still function as described. As in the first embodiment, the invention is not limited by the number of arrays of magnet rings (119) with corresponding electro-conductive rings (116), nor is the invention limited by the means chosen to axially move or actuate these two rings relative to one another.

While the invention has been described in connection with a preferred embodiment, it is not intended to limit the scope of the invention to the particular form set forth, but on the contrary, it is intended to cover such alternatives, modifications, and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

CLAIMS

What is claimed is:

1. An apparatus for transferring torque magnetically comprising:

a primary torque driving rotary member and a secondary driven rotary member;
the primary rotary member axially overlapping said secondary rotary member;
the secondary rotary member being surrounded by said primary member;
the primary rotary member having permanent magnets mounted on it;
the secondary rotary member having electroconductive elements and
magnetically permeable materials;
said secondary rotary member axially overlapped by said primary rotating
member wherein said primary rotary member's axial position relative to said
secondary rotating member can be varied by a suitable means; and
said primary rotating member being connected to and driven by a torque
producing device and said secondary rotating member being connected to a
torque utilizing device whereby rotation of the primary rotary member causes
rotation of said secondary rotating member by some or all of the magnetic flux
lines emanating from said permanent magnets mounted on said primary rotating
member cutting through the electroconductive material on said secondary rotary
member thereby generating torque and rotation in said secondary rotary member
in relation to the percentage of the total area that said secondary rotary member
is axially overlapped by said primary rotary member.

2. The apparatus according to claim 1 in which the primary rotary member's permanent
magnets contain rare earth materials.

3. The apparatus according to claim 1 in which the primary rotary member's magnets are supported by a cylinder made of a ferrous material.
4. The apparatus according to claim 1 in which the primary rotary member's cylinder is constructed of built up thin pieces of ferrous material each electrically separated from one another by a suitable electrical insulating material.
5. The apparatus according to claim 1 in which the secondary rotary member's electroconductive material is made of aluminum and its alloys.
6. The apparatus according to claim 1 in which the secondary rotary member's electroconductive material is supported by laminated pieces of ferrous material each electrically separated from one another by a suitable electrical insulating material.
7. The apparatus according to claim 1 in which the primary and secondary rotary members being independently supported.
8. The apparatus according to claim 1 in which the primary rotary member's magnets axial position is adjusted by an automatic device.
9. The apparatus according to claim 1 in which the secondary rotary member's electroconductive material is made of copper and its alloys.
10. The apparatus according to claim 1 in which the primary rotary member's permanent magnets contain neodinium, iron and boron.
11. The apparatus according to claim 1 in which the primary rotary member's permanent magnets contain alnico, iron and ceramic materials.
12. The apparatus according to claim 1 in which the secondary rotary member's electroconductive material is configured as a solid cylindrical ring geometry mounted on said secondary rotary member's outer cylindrical surface.

13. The apparatus according to claim 1 in which the secondary rotary member's electroconductive material is configured as a circumferential ladder geometry mounted on said secondary rotary member's outer cylindrical surface.
14. The apparatus according to claim 13 in which the secondary rotary member's electroconductive material's circumferential ladder geometry is divided into a plurality of electrically independent segmented arcs, mounted on said secondary rotary member's outer cylindrical surface.
15. The apparatus according to claims 13 or 14 further comprising electrically resistive materials being inserted into the electroconductive materials' electrical circuit.
16. An apparatus for transferring torque magnetically comprising:
- a primary torque driving rotary member and a secondary driven rotary member;
 - the primary rotary member axially overlapping said secondary rotary member;
 - the secondary rotary member being surrounded by said primary member;
 - the primary rotary member having electroconductive elements and magnetically permeable materials;
 - the secondary rotary member having permanent magnets mounted on it;
 - said secondary rotary member axially overlapped by said primary rotating member wherein said primary rotary member's axial position relative to said secondary rotating member can be varied by a suitable means; and
 - said primary rotating member being connected to and driven by a torque producing device and said secondary rotating member being connected to a torque utilizing device whereby rotation of the primary rotary member causes rotation of said secondary rotating member by some or all of the magnetic flux

lines emanating from said permanent magnets mounted on said primary rotating member cutting through the electroconductive material on said secondary rotary member thereby generating torque and rotation in said secondary rotary member in relation to the percentage of the total area that said secondary rotary member is axially overlapped by said primary rotary member.

17. The apparatus according to claim 16 in which the secondary rotary member's permanent magnets' contain rare earth materials.

18. The apparatus according to claim 16 in which the secondary rotary member's magnets are supported by a cylinder made of a ferrous material.

19. The apparatus according to claim 16 in which the secondary rotary member's cylinder is constructed of built up thin pieces of ferrous material each electrically separated from one another by a suitable electrical insulating material.

20. The apparatus according to claim 16 in which the primary rotary member's electroconductive material is made of aluminum and its alloys.

21. The apparatus according to claim 16 in which the primary rotary member's electroconductive material is supported by laminated pieces of ferrous material each electrically separated from one another by a suitable electrical insulating material.

22. The apparatus according to claim 16 in which the primary and secondary rotary members being independently supported.

23. The apparatus according to claim 16 in which the secondary rotary member's magnets axial position is adjusted by an automatic device.

24. The apparatus according to claim 16 in which the secondary rotary member's permanent magnets contain niobium, iron and boron.

25. The apparatus according to claim 16 in which the secondary rotary member's permanent magnets contain alnico, iron and ceramic materials.
26. The apparatus according to claim 16 in which the primary rotary member's electroconductive material is made of copper and its alloys.
27. The apparatus according to claim 16 in which the primary rotary member's electroconductive material is configured as a solid cylindrical ring geometry mounted on said primary rotary member's inner cylindrical surface.
28. The apparatus according to claim 16 in which the primary rotary member's electroconductive material is configured as a closed circumferential ladder geometry mounted on said primary rotary member's inner cylindrical surface.
29. The apparatus according to claim 28 in which the primary rotary member's electroconductive material's circumferential ladder geometry is divided into a plurality of electrically independent segmented arcs, mounted on said primary rotary member's inner cylindrical surface.
30. The apparatus according to claims 28 or 29 further comprising electrically resistive materials being inserted into the electroconductive materials' electrical circuit.

ABSTRACT OF THE DISCLOSURE

An apparatus for transferring torque magnetically with a primary rotary member and a secondary rotary member. The primary rotary member has permanent magnets mounted circumferentially on a cylinder, the secondary rotary member having a cylindrical geometry with electroconductive material arranged on its outer periphery and parallel to the axes of the rotary members. The secondary rotary member also having magnetically permeable material. The secondary rotary member is placed partially or totally inside the primary rotating member. The secondary rotary member's axial position relative to the primary rotating member can be varied by a suitable mechanical structure. This causes the two rotary members to axially overlap one another more or less as desired. Rotation of the primary rotary member causes rotation of the secondary rotary member, since magnetic flux lines emanating from the permanent magnets mounted on the primary rotating member, cut through all, or part of, the electroconductive material placed on the periphery of the secondary rotary member. This can vary the torque transmitted between the two rotary members, thereby enabling the varying of the rotational speed of the secondary rotary member relative to the primary rotary member.

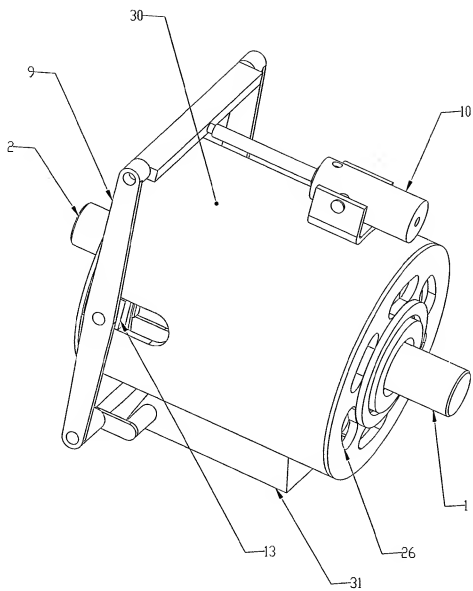


FIGURE 1

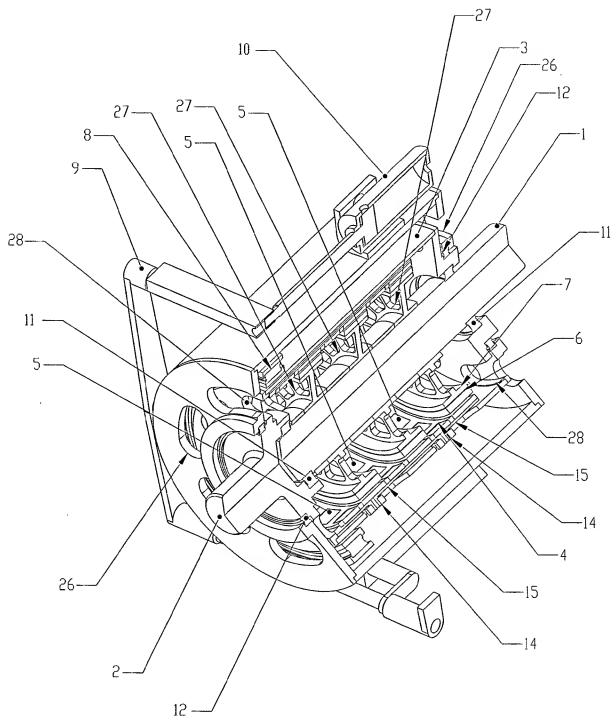


FIGURE 2

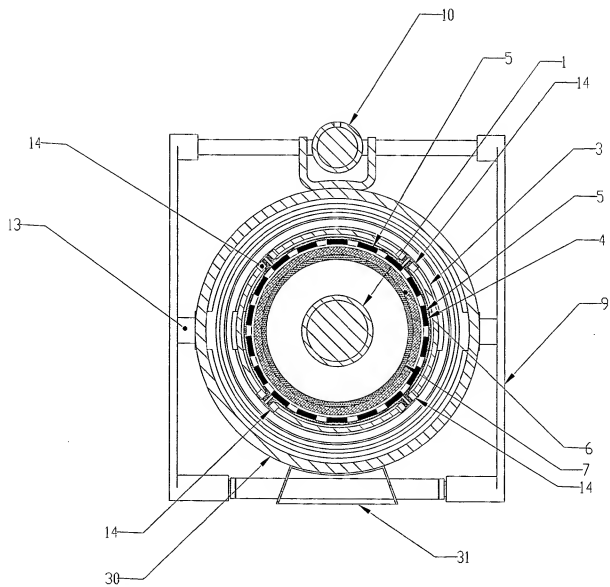


FIGURE 3

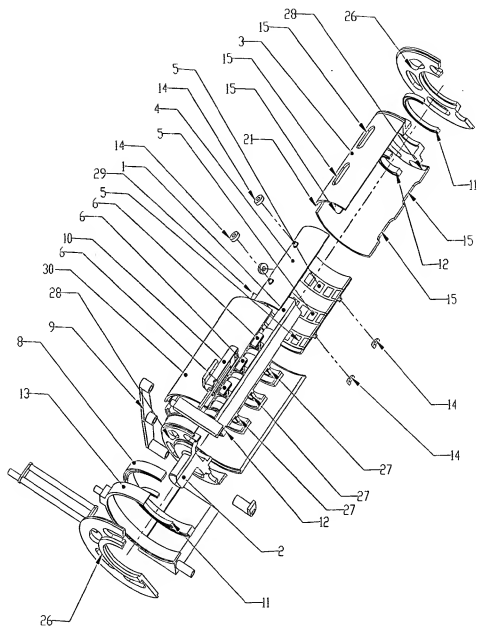


FIGURE 4

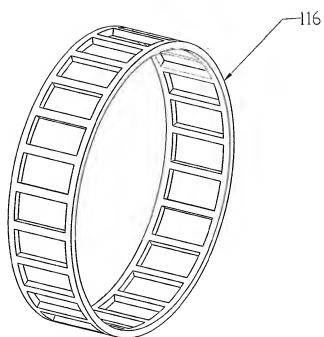


FIGURE 5

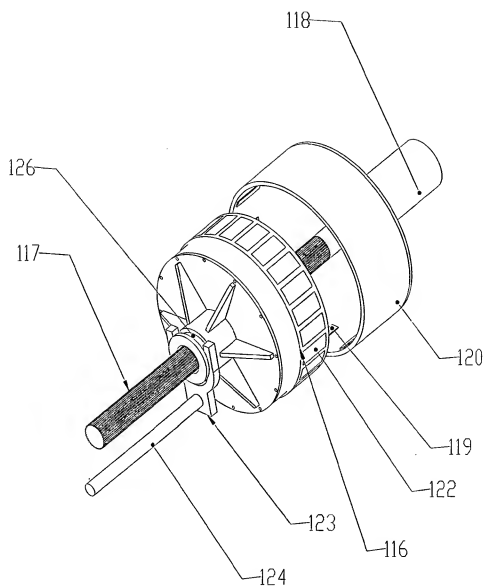


FIGURE 6

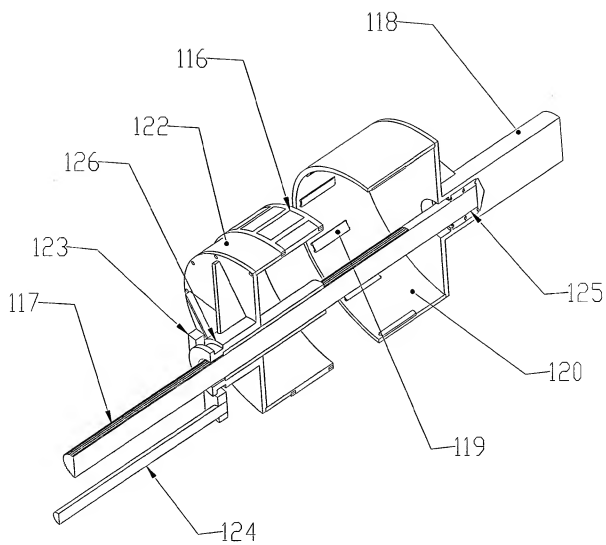


FIGURE 7

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

Declaration
Submitted
With Initial
Filing

OR

Declaration
Submitted after Initial
Filing (surcharge
(37 CFR 1.16 (e))
required)

Attorney Docket Number

FLUX 2004-1

First Named Inventor

Philip Corbin III

COMPLETE IF KNOWN

Application Number

Filing Date

Art Unit

Examiner Name

I hereby declare that:

Each inventor's residence, mailing address, and citizenship are as stated below next to their name.

I believe the inventor(s) named below to be the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

An Apparatus for Transferring Torque Magnetically

(Title of the Invention)

the specification of which



is attached hereto

OR



was filed on (MM/DD/YYYY)

as United States Application Number or PCT International

Application Number

and was amended on (MM/DD/YYYY)

(if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?	
			<input type="checkbox"/>	<input type="checkbox"/> Yes	<input type="checkbox"/> No
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

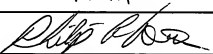

(Page 1 of 2)

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 21 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

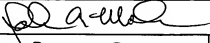
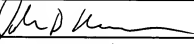
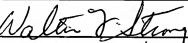
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION — Utility or Design Patent Application

Direct all correspondence to: <input type="checkbox"/> Customer Number: <input type="text"/>				OR <input checked="" type="checkbox"/> Correspondence address below	
Name The Miller Law Offices, PLC					
Address 801 Brickell Avenue - Suite #900					
City Miami		State FL		ZIP 33131	
Country USA		Telephone 305-803-5168		Fax 800-881-6174	
I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.					
NAME OF SOLE OR FIRST INVENTOR:				<input type="checkbox"/> A petition has been filed for this unsigned inventor	
Given Name (first and middle (if any)) Philip				Family Name or Surname Corbin III	
Inventor's Signature 				Date	
Residence: City TACOMA		State WASHINGTON		Country U.S.A.	
				Citizenship UNITED STATES	
Mailing Address 6716 EASTSIDE DRIVE NE SUITE 6					
City TACOMA		State WASHINGTON		ZIP 98422	
				Country USA	
NAME OF SECOND INVENTOR:				<input type="checkbox"/> A petition has been filed for this unsigned inventor	
Given Name (first and middle (if any)) ROBERT L.				Family Name or Surname DAHLIN	
Inventor's Signature 				Date	
Residence: City SUMNER		State WASHINGTON		Country U.S.A.	
				Citizenship UNITED STATES	
Mailing Address 9505 203RD AVENUE EAST					
City SUMNER		State WASHINGTON		ZIP 98390	
				Country U.S.A.	
<input checked="" type="checkbox"/> Additional inventors or a legal representative are being named on the 1 supplemental sheet(s) PTO/SB/02A or 02LR attached hereto.					

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

DECLARATION**ADDITIONAL INVENTOR(S)**
Supplemental SheetPage 1 of 1

Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
Given Name (first and middle (if any))		Family Name or Surname	
JOHN A.		MOLNAR	
Inventor's Signature 		Date 02/27/2004	
Residence: City	BELLEVUE	State	WA Country USA Citizenship US
Mailing Address 9064 NE 33 RD STREET			
Mailing Address			
City	BELLEVUE	State	WA Zip 98004 Country USA
Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
Given Name (first and middle (if any))		Family Name or Surname	
JOHN B.		RUSCONI	
Inventor's Signature 		Date 02/27/2004	
Residence: City	DUBLIN	State	CA Country U.S.A. Citizenship US
Mailing Address 8164 VIA ZAPATA			
Mailing Address			
City	DUBLIN	State	CA Zip 94568 Country U.S.A.
Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
Given Name (first and middle (if any))		Family Name or Surname	
WALTER F.		STRONG	
Inventor's Signature 		Date 02/27/2004	
Residence: City	SUDBURY	State	MA Country U.S.A. Citizenship US
Mailing Address 200 HUDSON ROAD			
Mailing Address			
City	SUDBURY	State	MA Zip 01776 Country U.S.A.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 21 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.